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The undersigned, being an officer duly authorised in accordance with Section 74(1) and (4) of the Deregulation & Contracting Out Act 1994, to sign and issue certificates on behalf of the Comptroller-General, hereby certify that annexed hereto is a true copy of the documents originally filed in connection with patent application GB0123844.3 filed on 4 October 2000.

I also certify that the attached copy of the request for grant of a Patent (Form 1) bears an endorsement, effected by this office, following a request by the applicant and agreed to by the Comptroller-General.

In accordance with the Patents (Companies Re-registration) Rules 1982, if a company named in this certificate and any accompanying documents has re-registered under the Companies Act 1985 with the same name as that with which it was registered immediately before re-registration save for the substitution as, or inclusion as, the last part of the name of the words "public limited company" or their equivalents in Welsh, references to the name of the company in this certificate and any accompanying documents shall be treated as references to the name with which it is so re-registered.

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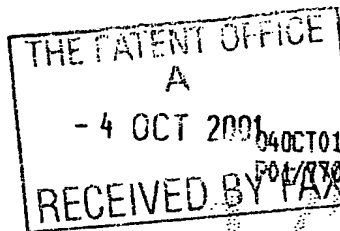
Under the Companies Act does not constitute a new legal entity but merely subject to certain additional company law rules.

Signed

William Morell

Dated 26 March 2009

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Patents Act 1977
(Rule 18)04OCT01 E664897-1 C77543
FOI/8700 0.00-0123844.3

Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form.)

The Patent Office

Gardifi Road
Newport
South Wales
NP10 8QQ

1. Your reference.

0123844.3

4 OCT 2001

Address and postcode of the or of
each applicant (indicate all applicants)

Daniel James Plant
Llanwinney Farm.
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Nr. Monmouth,
Monmouthshire
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NP25 4BU

Patents ADP number (if you know it)

If the applicant is a corporate body, give the
country/ies of its incorporation

4. Title of the invention

Energy Absorbing Flexible Sheet and Method of Manufacture.

5. Name of your agent (if you have one)

'Address for service' in the United Kingdom
to which all correspondence should be sent
(including the postcode)

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Venner, Shipley & Co.
20 Little Britain
LONDON

Patents ADP number (if you know it)

ECIA 7DH

F51/77
EB.

6. If you are declaring priority from one or more
earlier patent applications, give the country
and the date of filing of the or of each of these
earlier applications and (if you know it) the or
each application number

Country	Priority application number (if you know it)	Date of filing (day / month / year)
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7. If this application is divided or otherwise
derived from an earlier UK application,
give the number and the filing date of
the earlier application

Number of earlier application	Date of filing (day / month / year)
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8. Is a statement of inventorship and of right
to grant of a patent required in support of
this request? (Answer 'Yes' if)

- a) any applicant claimed to part is not an inventor, or
- b) there is an inventor who is not named as an
applicant, or
- c) any named applicant is a corporate body.

See rule 16(7)

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9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document.

Continuation sheets of this form

Description 6

Claim(s)

Abstract

Drawing(s) 3

10. If you are also filing any of the following, state how many against each item.

Priority documents

Translations of priority documents

Statement of inventorship and right to grant of a patent (Patents Form 2/77)

Request for preliminary examination and search (Patents Form 6/77)

Request for substantive examination (Patents Form 10/77)

Any other documents
(please specify)

11. I/We request the grant of a patent on the basis of this application.
Signature Dan Plant Date 03 October 2001

12. Name and daytime telephone number of person to contact in the United Kingdom Dan Plant (01600) 860 350

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Notes

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Patents Form 1/77

Energy Absorbing Flexible Sheet and Method of Manufacture.

Body impact protection solutions currently available are limited because they are either based upon a rigid exterior shell (for example as used in roller blade pads), that are uncomfortable to wear, or upon some form of foam laminate (as used in ski pad inserts), which provide poor levels of protection. A protective member is known from US 5138722 in which an energy absorbing material is contained in an envelope, the material remaining soft and flexible until it is subjected to an impact when its characteristics change rendering it temporarily rigid.

It is the object of the present invention to provide an energy absorbing sheet that is both flexible and lightweight and would produce a sheet form for impact solutions. It is a further object of the invention to provide an energy absorbing sheet that can be permanently attached and tailored into a garment of part thereof for body impact solutions. It is a further object of the invention that the sheet could be simple to cut into the required size and shape, and subsequently attached within or onto the garment. It is a further object of the invention that the system could be used to make flexible impact solutions that could be more easily stored, or rolled up after use, such as impact matting or indeed for such things as soft helmets or knee guards that can be rolled up after use for easy storage.

According to the invention there is provided a sheet comprising of an energy absorbing material held in place by an encapsulate. In one such embodiment the encapsulate can be any two sheets of material that are held with a designated gap between the two sheets. In such an embodiment two layers of sheets could be separated by columns or cross layers. These sheets could be made from any flexible thin material. Such as thin silicone sheet or even a textile. The two sheets would not have to be the same material, for example the top sheet could be a close weave textile containing a polyaromatic amide tread such as Kevlar® for abrasion resistance. This top sheet could also be coated with a waterproof membrane, or polyurethane so that it would further help to encapsulate the energy absorbing material. The lower sheet could also be a textile but could be a different material to the top sheet. By way of an example only this lower sheet could be a wicking micro fibre, with a brushed surface so that it is comfortable for the wearer. The joining columns could be any material. The columns prime use is to control the distance that the other two sheets are separated. They could be attached as columns that are individual and vertical or indeed at any angle. They could be of different lengths so that the controlled distance between the two outer sheets is variable. The joining columns could be in one or many sheets of material that wave up and down between the two outer materials. In one embodiment this could be considered like a piece of packaging cardboard; the top sheet, the centre wave and the bottom sheet.

In another embodiment of the invention there is provided a sheet comprising of an energy absorbing material held in place by an encapsulate. The encapsulate in this embodiment could be a 'spacer textile' or derivative thereof. These spacer textiles are readily available and can be woven in various

thicknesses. These spacer textiles can be considered to be similar to the sheets mentioned above. They have a top and a bottom layer, and are separated by a 'central section'. This central section can be only a few threads, or many treads or columns of material. The central section holds the two other layers together and also provides some spring to the system.

Another embodiment of the invention there is provided a sheet comprising of an energy absorbing material held in place by an encapsulate. The encapsulate in this embodiment could be a sheet of sponge like material. The sponge material could be similar to a washing up sponge but could be as coarse or as fine as needed for the end application. In this embodiment the core material could be considered as the sponge alone but it may have other thin sheets of material bonded to the top or bottom. By way of example only this could be the top sheet of close weave textile containing a polyaromatic amide thread such as Kevlar® for abrasion resistance. This top sheet could also be coated with a waterproof membrane, so that it would further help to encapsulate the energy absorbing material. There may be a lower sheet, also a textile, but could be a different material to the top. By way of an example only this could be a wicking micro fibre, with a brushed surface so that it is comfortable for the wearer. The shape of the core of sponge could be any shape at all. This could be in the shape of body specific impact protection components as we see today or a new derivative there of. After filling with the energy absorbing material, The system could also be post coated to further protect the soft central core.

The above describe a few ways of how the sheet of encapsulate could be configured. For reasons of simplicity they have been described as being in sheet form. These sheets do not have to be manufactured as planar sheets. They could be formed in a shape that more suited their end use. By way of example only this could be in the shape of a tube. This tube could either be made by joining two edges of a rectangular sheet together, thus giving a tube. It could be made by a circular weaving technique as used in socks and so on to give a tube from the start. This tube could of course be tapered. In one embodiment this could be worn on a part of the body such as a leg. In a further embodiment of the invention this sheet could vary in thickness. The thinner part would be where least impact protection would be needed and a thicker part would be where more protection was required. By way of example only this could be thinner over the back of the leg than the front, or thicker again over the knee than the thigh or shin. They could also be used in multi layers.

One of the similarities of the encapsulating sheets is that they all have a certain amount of spring so the encapsulating sheets will revert back to there open shape once external forces or impacts are removed. They also all have 'gaps' in them that can be filled or partly filled with energy absorbing material.

The gaps in the sheets of encapsulates mentioned above would then be filled with an energy absorbing material. The encapsulating sheets containing the energy absorbing material would remain soft and flexible until subjected to an

impact when its characteristics would change rendering it temporarily rigid, the sheet returning to its normal flexible state after said impact.

Preferably the energy absorbing material within the encapsulating sheet absorbs the impact force and spreads the load thereof during the impact. Preferably the energy absorbing material within the encapsulating sheet is a strain rate sensitive material such as a dilatent compound whose mechanical characteristics change upon impact. The preferred material would be a lightweight version of the strain rate sensitive material including dualite spheres. The preferred material is a Dimethyl siloxane hydroterminated polymer such as the material sold by Dow Corning under the Catalogue or trade number 3179 or lightweight version thereof.

At the present time it is not easy to fill such small thin areas with such a material. It is the intension of this invention that the method of manufacture of such a filling process could be possible by using something to transport the dilatent material into the 'air' gaps. This could be the heating of such an energy absorbing material so that it more easily flows into the gaps. It could be pumped or even pulled in with a vacuum.

A further method of getting the energy absorbing material into the gaps in the encapsulating sheets would be to thin it down, thereby reducing its viscosity to the point where it will easily flow. Any suitable material could be used to thin the energy absorbing material down. Preferably this would be a solvent. It is important that this solvent can be driven off from the energy absorbing material or dilatent compound without adversely affecting its energy absorbing characteristics. For example only, the dilatent material has been successfully thinned and then been left while the solvent evaporates off. The solvents used either individually or in mixtures so far are, propan2ol, methanol, ethanol, dichloromethane and trichloromethane, although any suitable solvent could be used.

Once the energy absorbing material or dilatent material has been thinned down it can be more easily transported into the gaps in the encapsulate. This could be any of the types described above, two sheet, foam or spacer fabric, or any configuration of these encapsulates in multi layers. It can also be transported into the sponge shapes. For this a low viscosity mixture of solvent and energy absorbing material has been used. The sponge is usually squashed and worked a little so that the low viscosity energy absorbing material works into the whole sponge. It can be moved into the encapsulate by poring into the centre, pumping or any other method. Once in the gaps in the encapsulate are filled, partly filled or coated, the energy absorbing material solution is left to 'dry out' the solvents can be driven off with heat, vacuum or any other suitable method.

Once the solvent has been forced off there is a potential reduction in volume of the energy absorbing material. This may not be a problem in certain embodiments, however if needed the encapsulating sheet could be pre-stretched before the energy absorbing material is put in. Once the solvent has been driven off, or the energy absorbing material dries out, the encapsulating

material could be released, thus accommodating the change in volume of the energy absorbing material due to evaporation of the solvent.

In a different embodiment the volume reduction could actually help to reduce the overall weight of the system. By way of example only if we consider one section of the encapsulating sheet. Let us think of the sheet in terms of the two layers, top and bottom, the central section being continuous columns. Looking from the end of the sheet down between the columns in this embodiment only, we would see a square section tube. This would be filled with energy absorbing material in solution or suspension. When the material dries off the volume will reduce. This could lead to the centre of the section becoming hollow. This can be considered to be similar to the way clay, in the form of slip in a mould, will dry out to leave a hollow part. These hollows could be left to skin off or filled with lightweight filler material. Preferably this lightweight filler could be dualite spheres. A new formulation of the dilatent compound could form a skin once exposed to the correct conditions. Thus once in place in the encapsulate all that is needed is for the solvent to dry off and the skin to form. Then we have a stable system with interior hollows. The energy absorbing material would then skin over when exposed to the appropriate conditions, in the same way that an open container of paint would skin over when left in contact with air. The core would then consist of the energy absorbent material held with in a thin skin of the same material. This would all be held in place within the encapsulated shape, be it spacer fabric, twin sheet or foam.

These configurations of encapsulated energy absorbing sheet could also be coated on either side by a suitable material to prevent the digress of energy absorbing material out of the system. These coating would also protect the system during subsequent washing or even dry washing cycles. The coating could be in sheet form, sealed at the edges. In a further embodiment the configurations of encapsulated energy absorbing sheet could be dipped in a suitable material to seal in the contents. This could be a silicone rubber that provided a thin layer to protect the sheet but would not adversely effect flexibility.

Several embodiments of the invention will now be described, by way of example only with reference to the accompanying drawings.

Figure 1 is a perspective view of one form of the encapsulating sheet only.

Figure 2 is a cross section of one form of the encapsulating sheet showing the energy absorbing material.

Figure 3 is a perspective view of another form of the encapsulated sheet.

Figure 4 is a perspective view of another form of the encapsulated sheet with holes

Figure 5 is a perspective view of another form of the encapsulating sheet only.

Figure 6 is a cross section of one form of the encapsulating sheet showing the energy absorbing material.

Figure 1 is a perspective view of one form of the encapsulating sheet 1. It comprises of central wave of material 2 joined to top sheet 3 and bottom sheet 4. These sheets may be made out of any material. In this embodiment all of the sheets are preferably textiles, which may have surface treatments or coatings. The central sheet 2 helps to maintain the separation of the top sheet 3 and the bottom sheet 4. The spaces or air gaps 5 are shown before the energy absorbing material is in place.

Figure 2 is a cross section through the above sheet once the energy absorbing material 6 has been placed in the spaces or air gaps. In this configuration the energy absorbing material has dried out leaving hollow centres 7. In this embodiment these centres could be filled with a low density material. This material could be dualite spheres or other low weight filler. The filler would help to add spring to the system and also help to keep the energy absorbing material in these defined shapes. In another embodiment the energy absorbing material could skin over, thus the hollow centres could just be left with a protective skin. The diagram still shows central waves of material 2 joined to top sheet 3 and bottom sheet 4.

Figure 3 shows another embodiment of the energy absorbing sheet. A square has been cut out so that the centre can be seen. The shape is only shown a square for this example only, but could be any shape. The entire sheet is encapsulated in a protective material 8. In this embodiment the core 9 has been dipped in material 8. Preferably this material is a silicone rubber. Core 9 is a foam type material that has been completely saturated in a solution of energy absorbing material. The solution of material has then dried out leaving the foam impregnated with the energy absorbing material. Then the core is dipped to give a protective layer to the system. The energy absorbing material in this embodiment is a dilatant compound or lightweight derivate thereof.

Figure 4 shows another embodiment of the energy absorbing sheet. A square has been cut out so that the centre can be seen. This embodiment has core 9 that has been dipped in material 8. There are also extra holes 10. These holes are formed in the foam at the beginning of the process. Thus this shows that the foam can be in any shape but also have cavities. These holes 10 will help to reduce weight and give the material more spring.

Figure 5 is a perspective view of another form of the encapsulating sheet 11. It comprises of central columns or pillars of material 12 joined to top sheet 13 and bottom sheet 14. These sheets may be made out of any material. In this embodiment all of the sheets are preferably textiles, which may have surface treatments or coatings. The central columns 12 helps to maintain the separation of the top sheet 13 and the bottom sheet 14. The spaces or air gaps 15 are shown before the energy absorbing material is in place. It is also possible to make spacer fabrics in this form. The columns are shown as solid in the diagram but could be thin material with holes or even lines or singe tread as in spacer textile.

Figure 6 is a cross section through the above sheet once the energy absorbing material 16 has been placed in the spaces or air gaps. In this configuration the energy absorbing material has dried out leaving hollow centres 17. In this embodiment these centre could be filled with a lightweight material. This material could be dualite spheres or other low weight filler. The filler would help to add spring to the system and also help to keep the energy absorbing material in these defined shapes. In another embodiment the energy absorbing material could skin over, thus the hollow centres could just be left with a protective skin. The diagram still shows central column of material 12 joined to top sheet 13 and bottom sheet 14.

1/3

FIG. 1

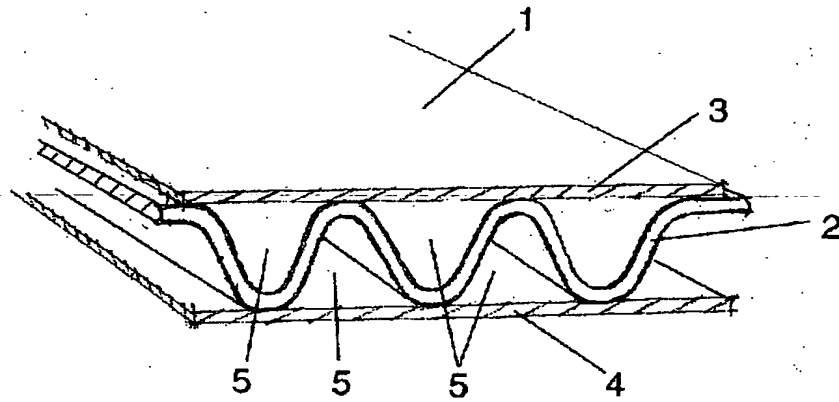
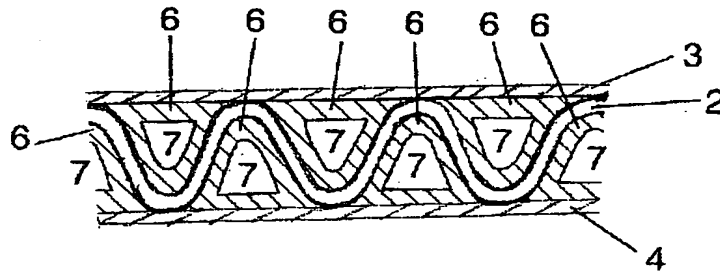


FIG. 2



2/3

FIG. 3

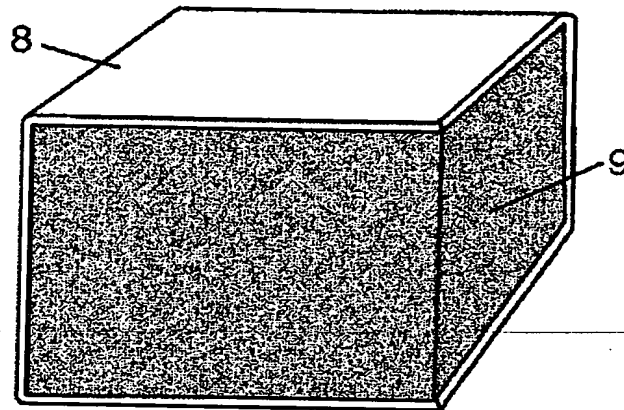
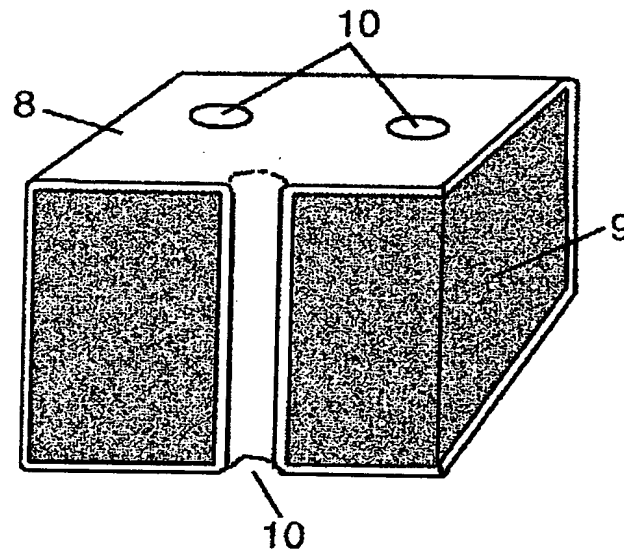


FIG. 4



3/3

FIG. 5

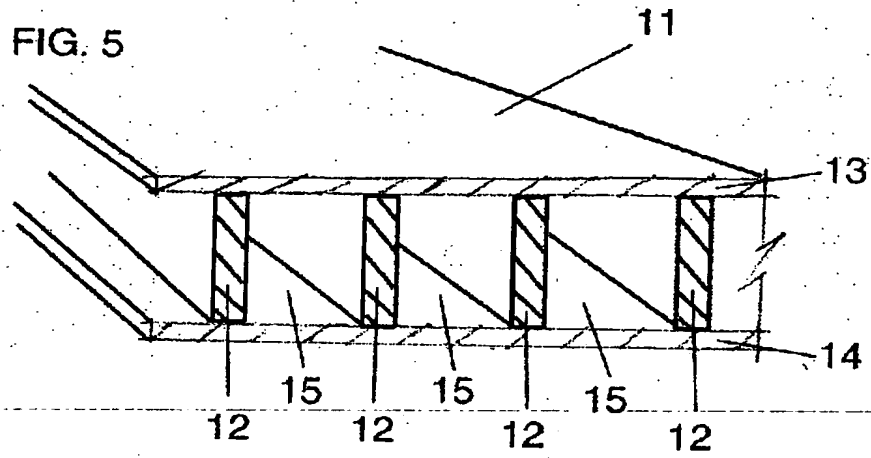


FIG. 6

